(Second Edition.)

PATENT SPECIFICATION

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" " Dec. 3, 1943. No. 20289/43.

579,657

One Complete Specification left (under Section 16 of the Patents and Designs Acts, 1907 to 1942): Aug. 1, 1944.

Specification Accepted: Aug. 12, 1946.

PROVISIONAL SPECIFICATION
No. 10807 A.D. 1943.

Improvements relating to Aircraft Propulsion Installations and Landing Gear

We, POWER JETS LIMITED, a British Company, of Whetstone Works, Whetstone, Leicestershire, and WILLIAM EVELYN PATRICK JOHNSON, a British Subject of the Company's address, do hereby declare the nature of this invention to be as follows:—

This invention relates to aircraft propulsion installations of the kind in which a compressor and gas turbine combination forms the motive source for jet propulsion or combined jet and air screw or like propulsion. As a matter of practicability and performance, power units of this class are installed in nacelles or fuselages arranged with forwardly facing intakes for air so that a useful degree of ram pressure due to forward speed is applied at the air intakes of the unit. The unit can conveniently be completely housed in such nacelles or fuselages which in order to develop the maximum possible ram pressure are made substantially pressure-tight, and the design of the air intake or intakes may be such that whilst high ram efficiencies are obtained in flight, there may be a reduction of pressure below atmospheric, for brevity called a depression, in the compartment at low speeds and during ground running. Such depression may adversely effect thrust and/or temperature conditions for example during take-off, and it may also be found difficult adequately to ventilate the compartment so as to prevent unduly high temperatures of the surrounding structure. It is a primary object of the present invention to meet these difficulties. A secondary object is to afford accessibility for servicing, for example for the purpose of replenishing the oil tank, examining filters etc.

According to this invention the nacelle, fuselage or compartment in which the propulsive unit is installed is provided with air intake passages in addition to the passage or passages normally used in flight, and these additional passages have valves or closures operating either automatically (as by reversal of pressure difference) or by hand (under the control of the operator) or by interconnection with some other apparatus such for example as retractable landing gear, the operation of which occurs more or less in the same phases of flight as those in which it is desired to control the passages.

In one example, a series of openings are provided in the skin of a nacelle, disposed as symmetrically as may be or in a selected relationship in regard to the air intakes of the power units of these openings for lightly loaded non-return valve closures in the form for example of spring loaded hinged trap-doors opening inwards. Thus when there is a compartment depression, the doors open and tend to relieve it, but as soon as there is sufficient forward speed to raise the compartment pressure by ram effect to a pressure similar to or in excess of the external pressure the openings are closed.

In another example, the same openings and doors are operated under the control of the pilot by suitable means. This mode of operation may have an advantage in that excessive ram pressure could be relieved for example if a high speed dive with the power unit throttled back, were contemplated.

A third and preferred alternative is to arrange for the control of the openings by means co-related with the retraction and extension of landing gear or maybe of wing flaps so that in take off, landing, or slow speed flight the openings admit air to the compartment whilst in cruising or high speed flight they are closed. The doors or valves may be provided with rubber or similar seats and it is at present contemplated that they may be of quite simple sheet metal construction and arranged to complete a smooth external surface when they are shut. The openings may be so located as to give access to oil filler arrangements or any other internal regions where ready access for servicing is desirable. There may be circumstances

[Price 2/-]

in which the openings may be used advantageously in full flight for example during ice forming conditions, and therefore the doors may be arranged to be operated by or simultaneously with any other devices which are to be operated in similar conditions.

Dated this 2nd day of July, 1943.
For the Applicants,
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PROVISIONAL SPECIFICATION
No. 20289 A.D. 1943.

Improvements relating to Aircraft Propulsion Installations and Landing Gear

We, POWER JETS LIMITED, a British Company, of Whetstone Works, Whetstone, Leicestershire, and WILLIAM EVELYN PATRICK JOHNSON, a British Subject, of the said Company's address, do hereby declare the nature of this invention to be as follows:—

This invention relates to landing gear for aircraft. It more particularly relates to retractable landing gear whether of the wheel, skid, or track type which is to be applied to aircraft having a fuselage or nacelle into which the undercarriage retracts, and which nacelle houses or forms part of a power unit installation in which considerations of pressure arise, involving a change of condition when the aircraft is on the ground or has a low forward speed as compared to ordinary flight. Such conditions may arise in a jet propelled or partially jet propelled aircraft including a prime mover or auxiliary propulsion devices consuming comparatively great quantities of air. In the case of a gas turbine prime mover arranged within a nacelle, there may be a marked reduction of pressure below atmospheric, for brevity called a depression, in the nacelle at low relative air speeds, and a positive pressure in normal flight. It may therefore be desirable to afford ventilation to the nacelle to prevent excessive depression at low speeds and sealing of the nacelle to retain the positive pressure at higher speeds. It will be appreciated that these two conditions correspond broadly to the conditions in which an undercarriage may be respectively extended and retracted. A further consideration is that with some types of installation there may be forwardly facing air intake openings to the nacelle, in a region where dirt and foreign bodies may be thrown up by the landing gear and may enter the nacelle to the detriment of the installation. It is a secondary object of the invention to avoid this.

According to the invention, aircraft landing gear provided for use in circumstances corresponding to the foregoing general conditions, is so made or provided that when extended, one or more substantial openings permitting the entry of air to the power unit are made in the wall of the nacelle, whilst when retracted, these openings are sealed and moreover sealed in such a way as to withstand a positive nacelle pressure. Further, where there are normal air entries which might pick up foreign matter, the operation or mechanism of the undercarriage may be arranged to be such that these openings are either well shielded or actually closed.

As an example, a rearwardly retracting undercarriage unit is associated with a nacelle within which is housed a gas turbine jet propulsion power plant. The undercarriage unit is arranged to be wholly retractable within the nacelle and is associated with a trap door or closure element which, when the undercarriage is extended, may constitute a fairing or an air brake as may be desired and which, when the undercarriage is retracted, forms a sealed closure completing the skin of the nacelle. Since this panel-like element is intended to withstand an internal positive pressure when closed, it is intended to be locked or retained, and sealed, in the closed condition. This may be achieved by making its edges a butt fit to the corresponding edges of the nacelle opening, forming these edges as channels, and using the known expedient of an inflatable elastic tube to act both as a seal and as a lock. Alternatively, the panel may be so arranged that it overlaps the edges of the fixed skin of the nacelle internally, when it is finally in the closed position, this being accomplished for example by displacing the panel as a whole or parts of it, in a lateral sense, after closing.

Dated this 3rd day of December, 1943.
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COMPLETE SPECIFICATION

Improvements relating to Aircraft Propulsion Installations and Landing Gear

We, POWER JETS LIMITED (in liquidation), a British Company, of Whetstone Works, Whetstone, Leicestershire, and WILLIAM EVELYN PATRICK JOHNSON, a British Subject, of the said Company's address, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to aircraft installations of the kind in which a compressor and gas turbine combination forms the motive source for jet propulsion or combined jet and airscrew or like propulsion. Power units of this class are for practical purposes installed in nacelles or fuselages (which for the purpose of description will be referred to collectively as nacelles) arranged with forwardly facing intakes for air so that a useful degree of ram pressure due to forward speed is applied in flight at the air intakes of the unit. When there is substantial forward speed there is within such nacelle a pressure higher than the ambient atmospheric pressure. The invention is concerned with such installations, when it is intended that the ram pressure should be an important factor contributing to performance. It is found as a matter of design that whilst the forwardly facing air intake may be adequate in conditions of flight and the contours surrounding it can be aerodynamically appropriate, there is a tendency for the condition to arise either in the stationary case or at low forward speeds, for example during take-off, for a sub-atmospheric pressure, or as it will herein be called, a depression, to arise in the nacelle which has an adverse effect on performance. The invention is intended to afford means for overcoming this difficulty and in some cases also to give subsidiary advantages, for example in regard to accessibility or in regard to undercarriage problems. The invention therefore refers to aircraft propulsion installations of the kind in which the power unit is enclosed in a nacelle which is intended to be substantially pressure-tight in most conditions of flight, and in which high ram efficiency is required and in which there may be a tendency for depression to occur in the nacelle in other conditions, which depression is deleterious to performance and may incidentally give rise to undue heating because of absence of thorough ventilation.

According to the invention, in an aircraft propulsion installation of the kind specified provision is made in the wall of the nacelle of one or more openings for the admission of air for consumption in the power unit and means to close these openings in appropriate circumstances of flight; such circumstances broadly speaking will arise simply by gaining adequate forward speed. The closures for the openings may be valve-like and adapted to close automatically when the ram pressure in the nacelle reaches a certain order of value relative to the ambient atmospheric pressure, and to this end they may be partly opened by gravity or by spring-loading. Alternatively the closures may be so inter-connected with the retractable undercarriage mechanism of the aircraft or with the operating system of such mechanism as to be open when the undercarriage is extended and closed when it is retracted. In any case the closures are preferably so arranged that they tend to be sealed against the escape of air from the nacelle by the pressure difference through the nacelle wall. The openings, or some of them, may be arranged so as to give ready access to selected regions or parts within the nacelle, e.g. for the inspection or servicing of parts of the power unit such as filters. In a case where a closure is connected with undercarriage mechanism the opening with which it is associated may serve as the embrasure which accommodates the retraction and extension of the undercarriage, and the closure constitutes what is normally called the undercarriage door.

The invention will now be described with the aid of the accompanying drawings, by way of example. In these drawings

Fig. 1 is a sectional view through a nacelle giving an indication of the power unit within it,

Fig. 2 is a similar section taken across the axis of the power unit,

Fig. 3 is a fragmentary view showing one of the closure elements seen from the axial direction, and

Fig. 4 a similar drawing of the same closure, inside elevation.

Fig. 5 is a side elevation partly in section showing the arrangement of a power unit in a nozzle which also includes a retractable undercarriage.

Fig. 6 is an axial view of the same, and

Figs. 7 and 8 fragmentary views of details of the sealing of the closure, which also serves as the undercarriage door.

Turning first of all to Figs. 1 to 4, the nacelle is shown with a skin or wall 1, having a forwardly facing main air entry indicated at 2, and within the nacelle there is mounted a power unit of the Whittle type having a compressor 3 and exhaust pipe 4. This unit is mounted in known manner on horizontally projecting trunnion mountings 5 with a third anchorage point at 6 to a spar 7. It will be noted that the nacelle is circular in section in view of the fact that it must withstand substantial loads arising from internal pressure. In the wall or skin 1 of the nacelle, air entry openings are provided at 8 and with each of these there is associated a valve-like closure 9 in the nature of a trap door. The openings 8 are arranged in the zone around the compressor 3 and are intended to be sufficiently large virtually to obviate any possibility of an internal depression in the worse cases, i.e. when the engine is running with maximum air consumption, the aircraft being stationary. They may be so arranged as to tend to direct the incoming air in the general direction of the two air intakes of the compressor, such general direction being indicated by the flow arrows in Fig. 1. The closures 9 are so contrived that whilst they are hinged for opening and have their edges made in such a way that the closures are virtually flush with the external surface of the nacelle when closed, they nevertheless conform with the circular and other curvature of the nacelle. Each closure is therefore made with the appropriate curvature of its main surface and each is mounted for hinging on an axis which permits its opening inwardly, having somewhat inwardly extending hinge lugs 9A for this purpose. The edges of each closure are formed so as to achieve the required flush exterior when closed, the nature of the formation being visible, for example, in Fig. 4 where a step is formed at 9B so that the closure can seal with a good seat against the edge of the opening 8 whilst the step along the edge adjacent to the hinged axis at 9C is made arcuate to permit swinging. The actual seating surface may be provided with rubber strip or like means to ensure a good seal. The closures may be quite free on their hinges if it be found in any given case that the pressure conditions are sufficiently marked to ensure their closing and remaining closed under the influence of ram pressure whilst opening when there is internal depression. In other cases, however, it may be found expedient nearly or completely to mass balance the closures about their hinged axes and to provide light spring opening tendency, since by this means the effects of high inertia forces in flight which might tend to open some of the closures can be avoided. It can be seen from Fig. 1 that at least one of the openings 8 can be arranged to afford access to the interior, in this case to the filler cap 10 of oil tank indicated at 10A. It will of course be apparent to those acquainted with the art, that the openings 8 may require to be reinforced round their margins for structural reasons.

Turning to Figs. 5 to 8, the case here is one in which the required opening for air is provided also as the undercarriage embrasure. The nacelle skin is here shown at 11 and the general arrangement of the power unit within it is as before, the trunnion mountings of the unit being supported on strong fore and after members 12 which extend between the front spar 13 and rear spar 14. The main undercarriage structure is also supported from these members and comprises suitable framework 15 forming a rigid volume frame to the lower part of which is pivoted at 16 an undercarriage leg 17 carrying a wheel 18. The leg includes a rotating spindle and at its upper end this has a bevel pinion 17A engaging a bevel rack 17B, fixed to the structure 15, whereby as the undercarriage is retracted and extended the plane of the wheel 18 is rotated through approximately 90 degs. The fact that a jet propulsion aircraft lends itself to the use of exceptionally short undercarriage legs facilitates a construction of this type and may enable the undercarriage to be stowed within such a nacelle as that depicted. The undercarriage is presumed to be operated by any suitable means such as a hydraulic jack.

The undercarriage embrasure can be seen in Fig. 6 at 20. Two sliding doors are provided at 21, 22, respectively, these constituting not only undercarriage doors but airtight closures to the opening 20 when the undercarriage is fully retracted. Here again the closures are curved so as to conform with the circular section of the nacelle and the panels forming the closures are in the nature of sliding panels, the forward and rearward edges of which are guided by running in grooves indicated at 23. The meeting edges are provided with sealing means illustrated in Fig. 8, each constituted by a channel member 24 which serves to stiffen the edge of the panel and also to retain a rubber or other like sealing element 25 which constitutes as can be seen in the drawing, a tongue and groove seal which, whilst not being susceptible to jamming or sticking, will at the same time tend to be improved, as an airseal, by internal pressure. The other edges of the panels are

also provided with sealing strips in the form of attached strips 26 of rubber or the like, which slide on the skin 11 when the panel is moving and which tends to seal under pressure. The two closure panels 21 and 22 are operated by an opposed piston hydraulic jack 27 and rods of which move bell cranks 28, which are connected to the closures by links 29, this mechanism being duplicated or repeated as may be necessary lengthwise, in view of the comparative length and probable flexibility of the panels themselves. It is intended that the jack 27 shall be operated as a double acting jack by a system which is precisely analogous to that applicable in the ordinary case of undercarriage doors, that is to say, complete opening of the closures is followed by the operation of undercarriage extension whilst the doors only begin to close after complete undercarriage retraction. In view of the particular kind of construction proposed and the fact that the doors themselves will be well supported and must be fairly robust when closed, it may be found that in such a case the provision of undercarriage uplocks may be omitted, reliance being placed upon the doors themselves for preventing drooping of the undercarriage in flight.

It is to be understood that in this application of the invention it is conceived to be likely that all the circumstances in which the additional air opening is required, correspond with the circumstances in which the undercarriage would normally be extended; it is of course evident that in normal practice the undercarriage is extended during preliminary running up on the ground and during take-off, and these are the most important phases in which nacelle depression is liable to arise. There is another case where depression is to be avoided, namely: when, during a landing it is found necessary to make full use of engine power, and here again the practical condition will normally be, with the undercarriage extended.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In an aircraft propulsion installation of the kind specified, the provision in the wall of the nacelle of one or more openings for the admission of air for consumption in the power unit, and means to close these openings in appropriate circumstances of flight.

2. In an aircraft propulsion installation of the kind specified, the provision in the wall of the nacelle of one or more openings for the admission of air for consumption in the power unit, and valve-like closures for these openings which are adapted to close automatically when the ram pressure in the nacelle reaches a certain order of value relative to the ambient atmospheric pressure.

3. In an aircraft propulsion installation of the kind specified, the provision in the wall of the nacelle of one or more openings for the admission of air for consumption in the power unit, and closures for these openings which are so interconnected with retractable undercarriage mechanism of the aircraft or the operating system thereof, as to be opened when the undercarriage is extended and closed when it is retracted.

4. In an aircraft propulsion installation according to any previous claim, closures for the openings which are arranged and adapted to be sealed against the escape of air from the nacelle by the pressure difference between the interior and exterior of the nacelle.

5. In an aircraft propulsion system according to any previous claim, the arrangement of one or more of the openings so as to give ready access to selected regions or parts within the nacelle for inspection or servicing.

6. In an aircraft propulsion system according to Claim 3, the arrangement whereby an opening as claimed serves also as the embrasure through which the undercarriage moves during retraction and extension, and the closure for such openings encloses the undercarriage when retracted.

7. An aircraft propulsion system having openings and closures therefor constructed and adapted to operate substantially as described with reference to Figs. 1 to 4 of the accompanying drawings.

8. An aircraft propulsion system having an opening and closure therefor in conjunction with a retractable undercarriage, substantially as described with reference to Figs. 5 and 6 of the accompanying drawings.

Dated this 1st day of August, 1944.

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579,657 COMPLETE SPECIFICATION

SHEET 1

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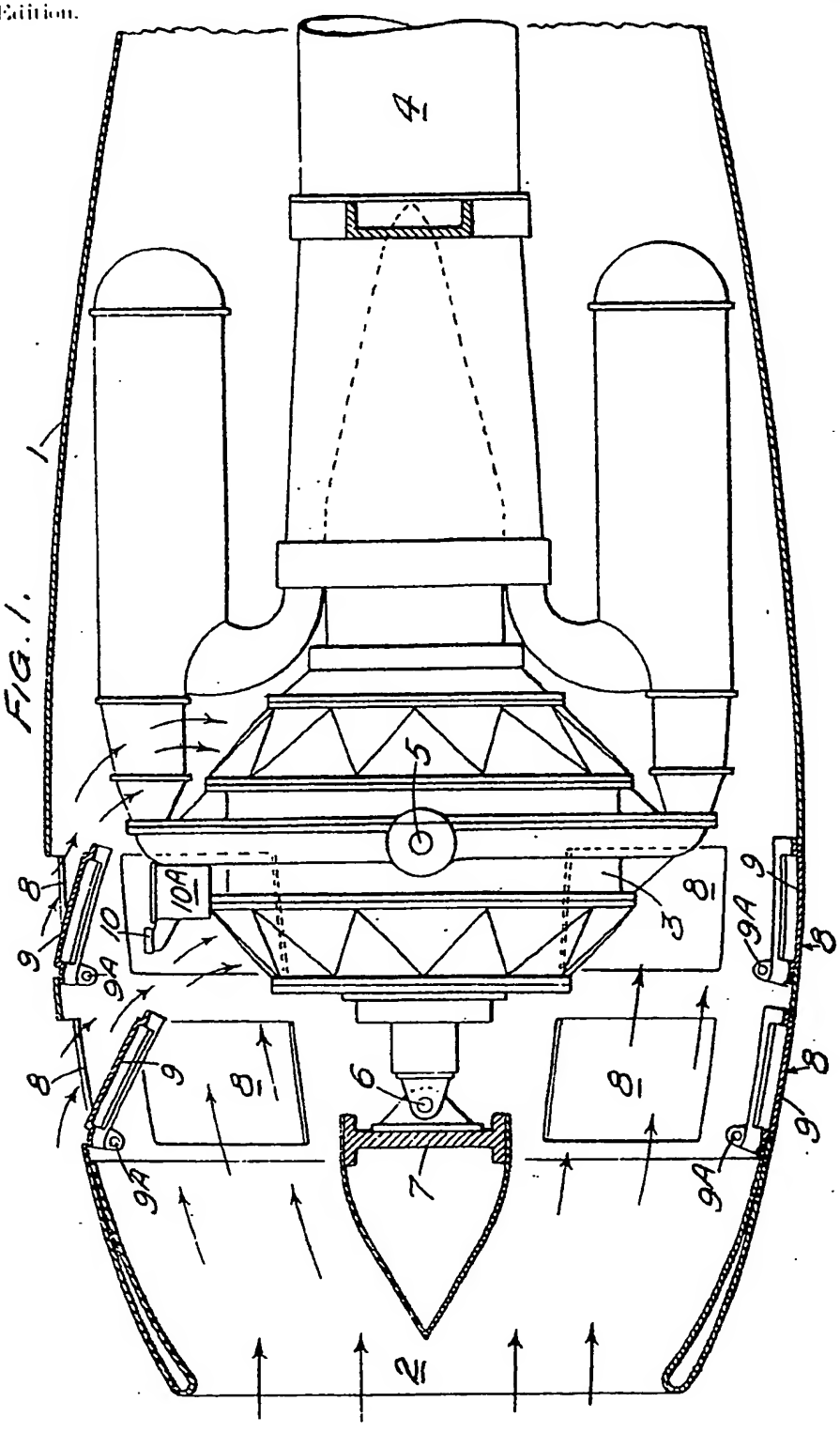

FIG. 1.

[This Drawing is a reproduction of the Original on a reduced scale.]

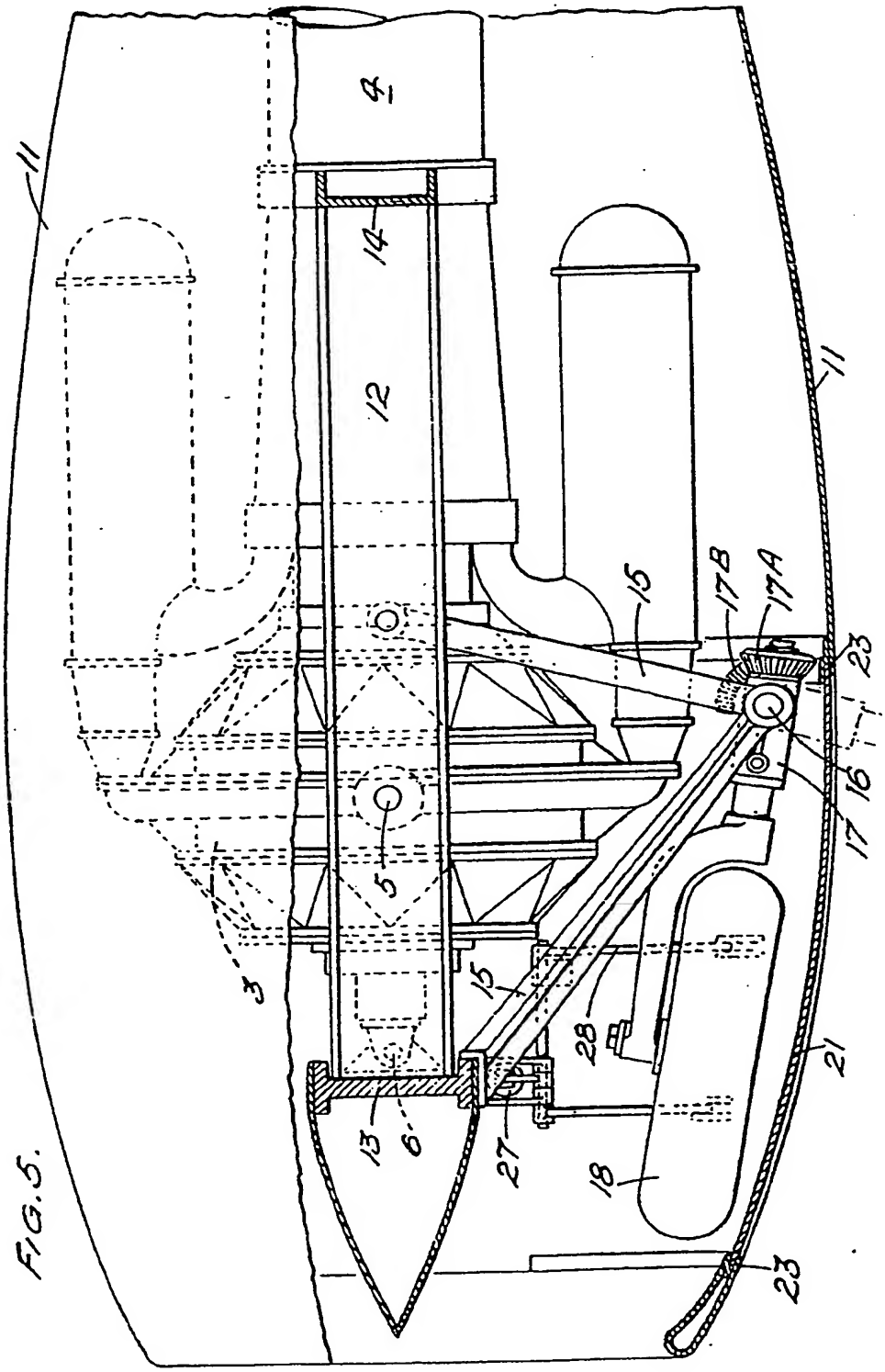

FIG. 5.

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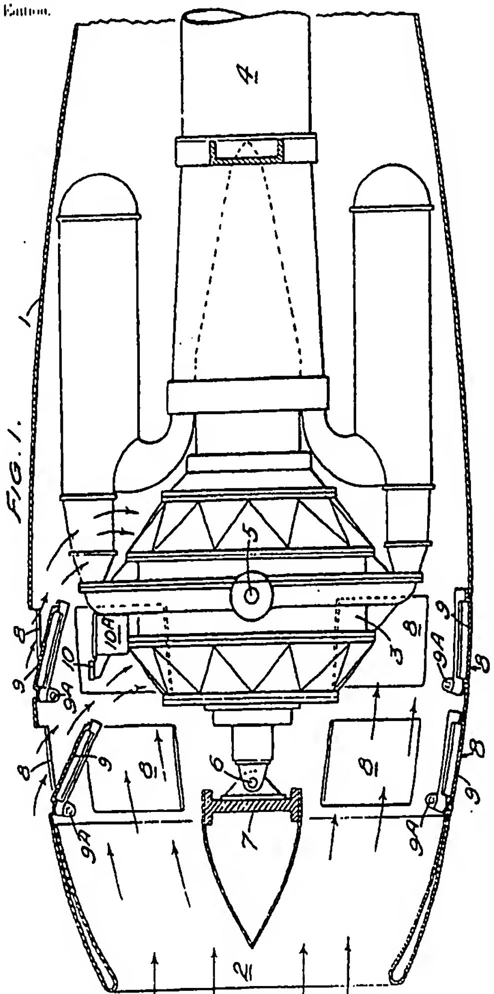

FIG. 1.

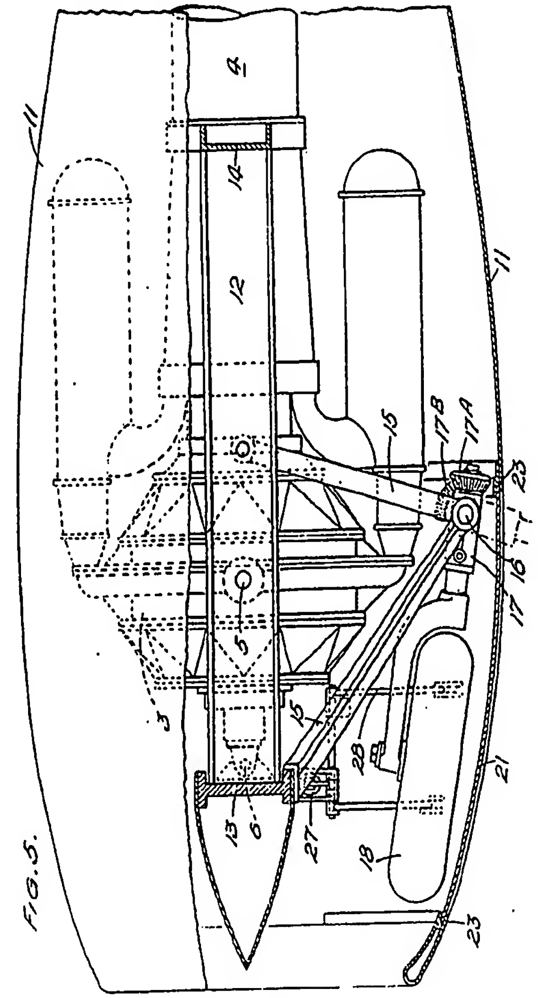

FIG. 5.

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SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 2.

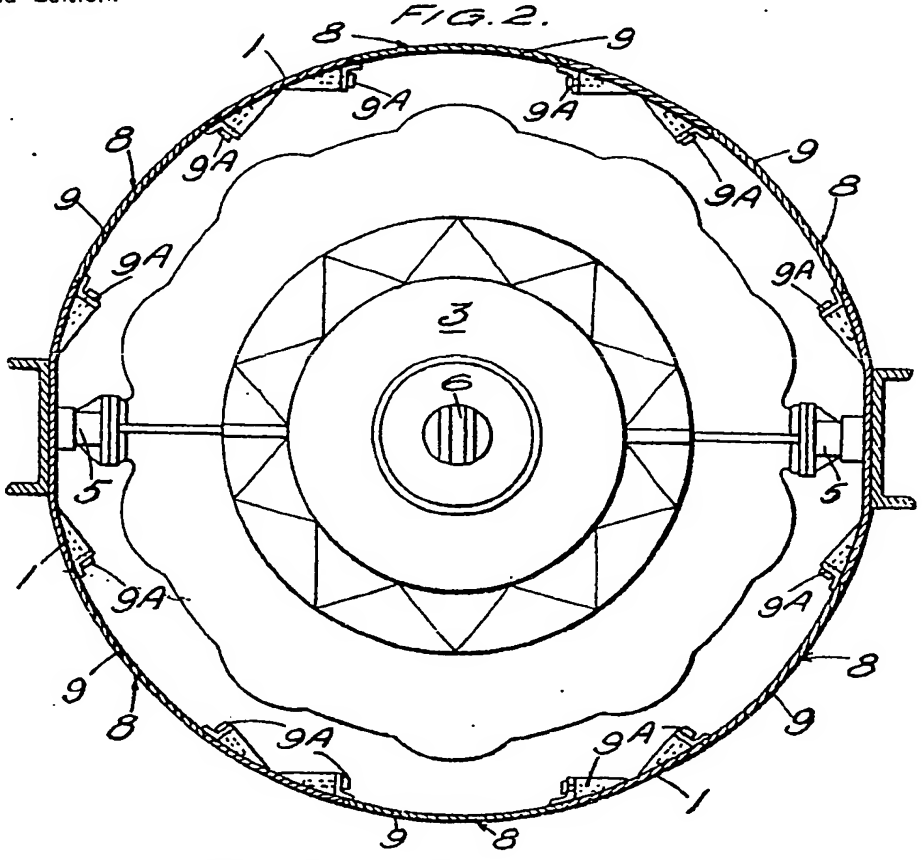

FIG. 3.

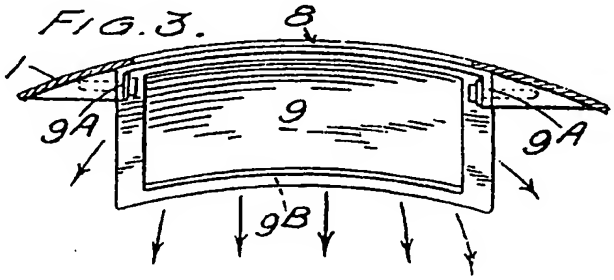

FIG. 4.

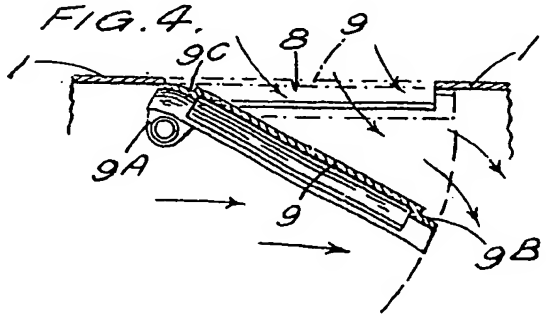

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FIG. 6.

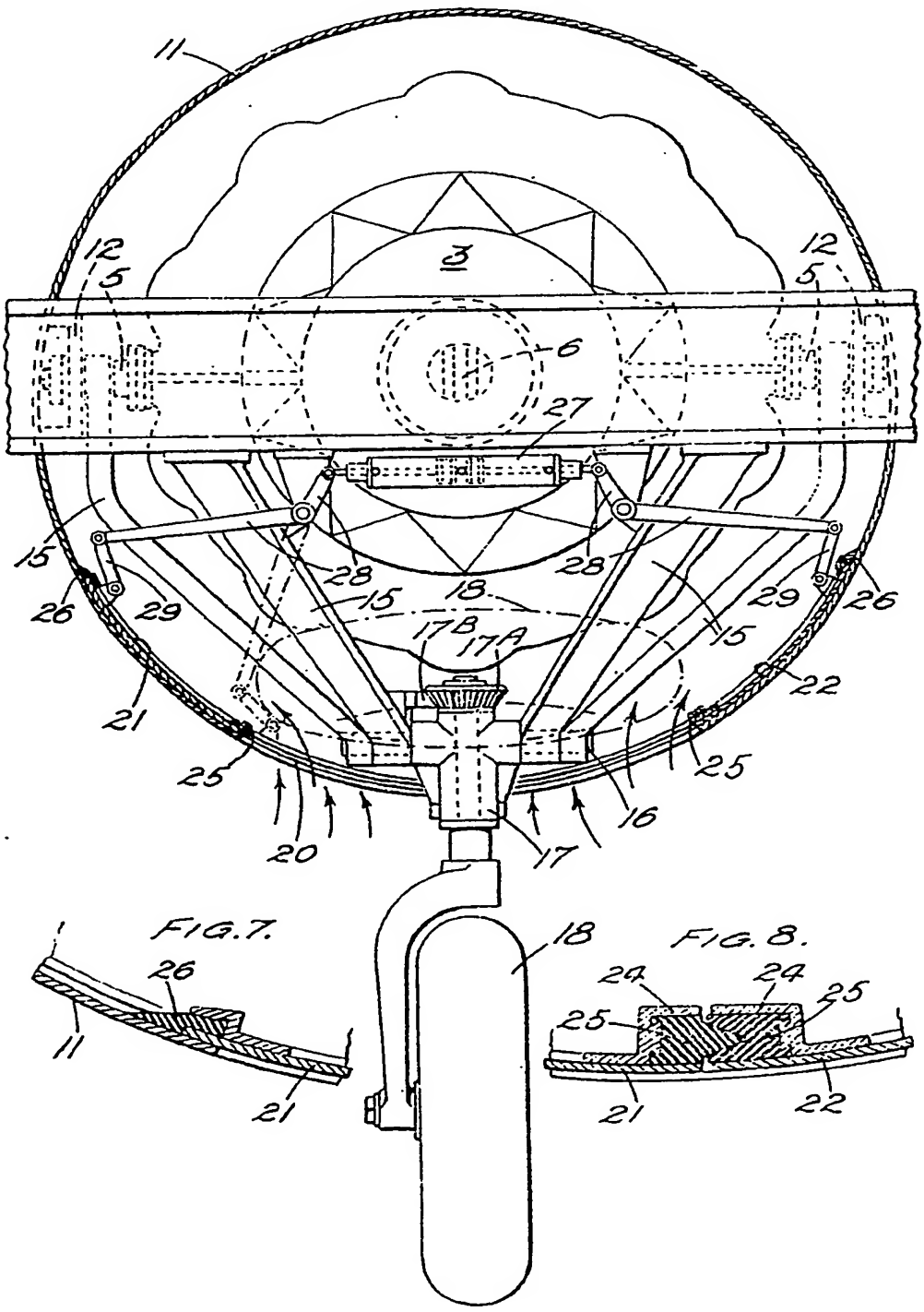

FIG. 7.

FIG. 8.

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SHEET 2

FIG. 2.

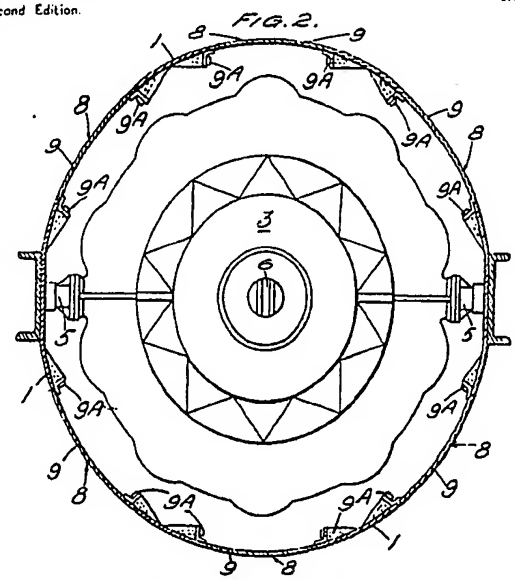


FIG. 3.

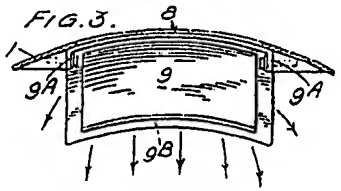
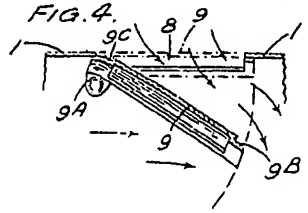


FIG. 4.



SHEET 4

FIG. 6.

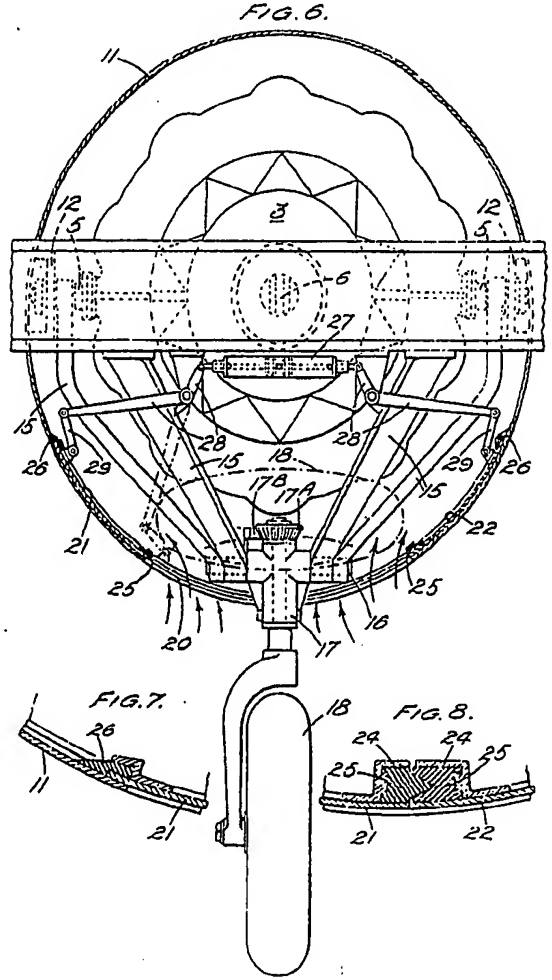


FIG. 7.

FIG. 8.

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